effect of weathering during the hot months on both the yield and quality of wheat is being ascertained.

A. HOWARD.
G. L. C. HOWARD.

Pusa, November 18, 1909.

A Note on the Gilded Metal-work of Chiriqui, Central America.

AMONG the minor ethnological problems which America offers in such variety, not the least interesting is that of the origin, significance, and method of production of the specimens of gold-work found so abundantly in certain parts of Central America and in the north-western regions of the southern continent.

The earliest European voyagers who reached the shores of the New World directed attention in their narratives to the gold ornaments and little images of "frogs, birds and men" found in the hands of the natives, and, as Humboldt urged long ago, arguing erroneously from the accumulated riches of generations of savages, they attributed great mineral wealth to the newly discovered lands, giving them such sounding names as Costa Rica and Castillo del Oro.

Articles of gold alloy are widely distributed throughout South America, and vary as greatly in artistic and technical execution as in the purity or baseness of the metal from which they have been fashioned. This metal-work has long been known to students, as well as to treasure-hunters, and is of so extraordinary a character that it at once attracts attention. Running riot, heedless of the proprieties, its motives include every variety of zoomorphic design—human, bestial, bird, fish, or reptile; all types of life are represented, together with monstrosities and ambiguous shapes bordering frankly on the diabolical.

A certain amount of South American metal-work finds its way every year to England through dealers who purchase it from natives and speculators who make it their business to explore the ancient burial places. Practically the whole of this is melted down on account of its intrinsic value, but it is comparatively seldom that objects of artistic or archæological interest are lost to science in this manner, by far the greater portion of the work being of the crudest description.

The present letter deals more particularly with the gilded metal-work of Chiriqui, on the southern boundary of Costa Rica, which presents features of peculiar interest. It has been studied carefully by Holmes, whose work on the subject, embodying references to the earlier literature dealing with it, is to be found in the report of the Bureau of Ethnology for the years 1884–5.

The immediate interest of the subject turns upon the occurrence of objects fashioned from copper-gold alloys of very variable composition, the latter metal being present in some instances in a proportion insufficient sensibly to alter the colour of the copper, whilst, nevertheless, the surface of the objects presents a burnished coating of fine and splendent gold. In many examples the film of precious metal is so slight that it has all the appearance of electro-plated work, and many conjectures have been hazarded to explain the method by means of which the native artist produced the effect.

Holmes, in the treatise already cited, quotes, on the authority of Bollaert, a reference to the works of Acosta to the effect that the Indians of New Grenada gilded copper by rubbing it with the juices of certain herbs and afterwards subjected it to the action of fire, when it took the gold colour, but states that he had not been able to find the passage in question. The present writer has also searched the pages of Acosta in vain, but it is probable that Bollaert quoted from memory the following passage in the "History of the Indies" of Gonzalo Fernandez de Oviedo (Edit. Amador de los Rios, vol. iv., p. 189), where that writer says, freely to translate the paragraph:—"I would wish to say how the Indians [of the Antilles, and especially those of Hayti] know well how to gild the little things they make of copper, very yellow like gold. They have in this such skill and excellency, and give such a deep lustre to that which they gild that it seems to be good gold of 23 carats or more by its colour when it leaves their hands. This they do with certain herbs, and is such a great secret that whoever of the goldsmiths of Europe or of any other part shall find it out, he will be a very rich man, and that in a very short time if he uses this manner of gilding." The old historian of the Indies made efforts to learn from the Indians this secret process, but they excused themselves on the plea that the herbs made use of were unknown to them, and that the small quantity they possessed of them came from very distant countries.

"It is not impossible," says Holmes, "that an acid may have been applied which tended to destroy the copper of the alloy, leaving a deposit of gold upon the surface, which could afterwards be burnished down. . . . It is possible that the film of gold may in some cases be the result of simple decay on the part of the copper in the alloy . . . but the surface in such a case would not be burnished, whereas the surfaces of the specimens are all neatly polished."

The operation above mentioned, whereby the apparent quality of articles of gold alloy is improved by the artificial enrichment of the superficial layer, is one frequently practised among goldsmiths, who term it "colouring." A hot process, involving the use of fused salts, is generally made use of (*vide* T. K. Rose, "Metallurgy of Gold," edit. 1906, p. 19; W. T. Brantt, "Metallic Alloys," London, 1896; and Gee, "Goldsmith's Handbook," 1881).

Considering it probable that a germ of truth lay in the information given by the Indians to Oviedo, the writer made several experiments of a simple character to endeavour to clear up this point. It was found that by acting upon a base alloy with dilute nitric acid, a black lustrous film of gold could be readily obtained by removing in solution a portion of the copper. By heating the object thus treated out of contact with air, the black film of gold is annealed, changing to the yellow modification, and is left in a condition to be readily burnished with any suitable implement, for example, a water-worn pebble of quartz.

The mineral acids being, presumably, unknown to the craftsmen of pre-Colombian America, advantage was taken of the solubility of copper in organic acids in the presence of air, and after a few successful preliminary experiments with the pure chemical products, various acid plant juices, the "herbs" of Oviedo's Indians, were tried, and fully answered expectation. There can be little doubt that the Indians had no need to ransack "distant countries" for the wherewithal to gild their ornaments; but every craft has its mysteries.

It was found that among the various organic substances tried in the course of the experiments few effected the required reaction so readily as urine, which, with free access of air, rapidly covers the surface of the alloy with a coating of hydrated copper salt readily soluble in acid plant juice. When performed with the aid of these natural reagents, the operation is a very tedious one, the gold film, in the case of base alloys, taking months to acquire sufficient substance to admit of being burnished; but time signifies little to the savage.

In conclusion, although not desirous of affirming that the procedure described was that invariably followed by the Indians in the production of gilded work, the writer is decidedly of the opinion that their operations broadly followed the lines indicated in the present letter.

OSWALD H. EVANS.

"Arauco," South Harrow, February 1.

Suggested Common Day of Meeting for London Societies.

WILL you permit me to make a suggestion regarding the days of meeting of learned societies in London? At present these days seem to be selected in a very arbitrary manner, with the result that the provincial members of the societies are often called to London on several days during the same week. For instance, last autumn I ought to have attended no fewer than four such meetings during the same week, namely, on Monday, Tuesday, Thursday, and Friday. It is, of course, impossible for the majority of provincial members of London societies to give up so many days—we are generally compelled in such circumstances to abandon all the meetings. By some curious law

of chance, moreover, it generally happens that two meetings occur with just an interval of one day between them, which makes it still more difficult to attend either.

Would it not be possible to fix one day, namely, Friday afternoon and evening, as a general day of meeting for the societies? This would, I feel sure, allow many provincial members to come down to London for the occasion, partly because they could merge the Friday with their "week-end," and partly because they might have the chance of attending several meetings the same afternoon and evening. I doubt whether such an arrangement would inconvenience many of the London members; but, even if it does, the London members might perhaps be willing to give way, because to them, in any case, attendance is much more easy than it is to men who live perhaps hundreds of miles away. I have discussed the matter with several friends in Liverpool, all of whom seem to be favourably impressed with the idea. RONALD ROSS.

Johnston Tropical Laboratory, University of Liverpool, February 5.

The Meaning of "Ionisation."

IN his interesting notice concerning the work of Arrhenius, published in NATURE of February 3, Prof. Walker, in a somewhat ambiguous manner, refers to "the notion and practical definition of degree of ionisation" as the great positive contribution of the distinguished physicist. "Whatever be our views of the origin and nature of ions, we must" . . . —he says—"have recourse to the notion of degree of ionisation." It is a little difficult to see how we are to have recourse to a notion if we are not clear what view that notion is based upon and includes. To appreciate Prof. Walker's position, it is essential that we should know precisely what meaning he attaches to the words I have quoted—what conception underlies them. I would beg Prof. Walker to tell us, in clear, unmistakable terms, what exactly he would have us understand by the word *ionisation*.

When the Royal Society has completed its Catalogue of Scientific Papers of the last century, it will doubtless be compelled to prepare a dictionary in explanation of the terminological inexactitudes to be found in its Proceedings and other journals; of these, *ionisation* will be one of the most difficult to interpret. Prof. Walker will render real service if he will tell us in what sense or senses he uses the word throughout his notice; does he or does he not use it as connoting explicitly the separation of a substance in solution into several portions, each capable of acting as a distinct kinetic unit? This, I believe, was the doctrine enunciated by Arrhenius in 1887, and which, if I mistake not, he still professes. Does Prof. Walker advocate such doctrine?

HENRY E. ARMSTRONG.

PROF. ARMSTRONG and I look at *ionisation* from different points of view. He is chiefly interested in an interpretation of the process and phenomena of ionisation in terms of the kinetic molecular theory. I am chiefly concerned to have a theory, whatever be its exact mechanical interpretation, which is capable of being mathematically formulated and of acting as a guide in quantitative investigation. My position, in short, is that of the astronomer who is content to have Newton's law for practical purposes, and only takes a speculative interest in theories of the nature of gravitation.

Possibly the best analogue in physics to Arrhenius's theory of electrolytic dissociation is van der Waals's theory of the continuity of the gaseous and liquid states. Van der Waals's theory can be put in the form of a comparatively simple equation which is very successful in representing the facts in broad general outline, though in many cases it proves to be imperfect in detail. Although the kinetic molecular assumptions on which van der Waals based his theory may be questioned, his equation will remain an important aid to investigation in its special domain until it is superseded by another of comparable simplicity and of greater comprehensiveness.

JAMES WALKER.

The Invention of the Slide Rule.

IN NATURE of January 13 (p. 307) Dr. Alexander Russell, in writing of the invention of the slide rule, says:—"Supporting the latter view is the fact that he (Oughtred) published (1633) his 'Mathematicall Recreations' under the pseudonym of Henry Van Etten." This evidently implies that Oughtred was the author of the said "Mathematicall Recreations," whereas the very title of the work shows that it was a translation, and not an original contribution. It reads:—"Mathematicall Recreations; or a collection of sundrie problemes and experiments in arithmeticke, cosmographie, astronomie, architecture, chimistrie, &c., extracted out of the ancient and moderne philosophers, *now delivered into English tongue* with the examinations, corrections and augmentations by W. Oughtred."

The italics are ours. The translation was made from the French of Henry Van Etten's "Recreation Mathematique, composee de plusieurs problemes, plaisants et facetieux, en fait d'Arithmétique, Geometrie, Mecanique, Optiq.; et autres parties de ces belles Sciences." The accents are missing in the title-page. The work was published in Paris in 1624. The name of Henry Van Etten is indeed a "pseudonym," but it is that of Jean Leurechon (1591–1690), a French Jesuit of uncommon mathematical versatility, and not that of William Oughtred (1574–1660), an English divine of no less uncommon mathematical ability.

BROTHER POTAMIAN.

Manhattan College, New York City, January 27.

Transit of Halley's Comet.

MAY I point out that at the time of the transit of Halley's comet the sun will be above the horizon at the North Cape? The Cape is distant 18° 49′ 20″ from the pole, and the declination of the sun at midnight of May 18 will be 19° 31′ 42″; adding 27′ 22″ for refraction, the sun's altitude at midnight would be 1° 9′ 44″, and the altitude would increase before the first contact, which will take place at 16h. 6m. local time. The Cape rises to a height of 968 feet, and there should be a very fair sporting chance of seeing something of whatever there may be to see during the sixty minutes' duration of the transit.

C. S. TAYLOR.

Banwell Vicarage, Somerset, February 11.

Dangerous Lecture Experiments.

ALTHOUGH it is no part of my duty to teach chemistry, I have on several occasions had to perform an experiment which Mr. Marle quotes (p. 428) as being dangerous, viz. the collection of hydrogen from the action of sodium on water. I can fully endorse his warning. Twice a violent explosion took place; but I found that if the piece of sodium is carefully cleaned so that all its surfaces are bright, and cold water used, the experiment can be carried out in safety. I do not know if these important details have found their way into the practical manuals in use in chemical laboratories. If not, I trust that this experiment is not one that beginners are directed to make.

M. D. HILL.

Eton College, Windsor, February 11.

Aged Tadpoles.

LAST year I reared about five thousand tadpoles, and, dividing them into twenty portions, brought most of them to the frog stage. As they matured, and the numbers became smaller, the survivors were gradually brought together again into a few vessels, finally into one. Of those which were in the tadpole stage in November, none changed to frogs. They died one by one until only two are left. These are quite healthy—active feeders with long tails and hind legs, but no appearance of fore legs. Perhaps some of your readers will be able to say whether it is usual to have tadpoles a year old, and whether one may expect any change to take place now—whether, perhaps, like Axolotl, they may not exhibit the power of reproducing their own kind if they remain alive.

JOHN DON.

Carrick Academy, Maybole, N.B.